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PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improved Manufacture of Worts, Fermented and Distilled Beverages, and other Products Resulting from the Mashing of Starchy Materials.

We, THE WAHL-HENIUS RESEARCH LABORATORY, a corporation organised under the laws of the State of Illinois, and having an office at 1135, Fullerton Avenue, Chicago, in the State of Illinois, United States of America, Assignees of ROBERT WAHL, Chemist, of 1135, Fullerton Avenue, Chicago, in the County of Cook and State of Illinois, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a method or process of utilising for technical purposes ungerminated vegetable substances containing translocation diastase and insoluble carbohydrates, phosphates and proteids. The invention is more particularly concerned with the utilisation of substances containing or consisting largely of the aleurone layer of vegetable seeds. The most common source of supply of such material is bran and other cereal matters of a similar nature, such as the offal of pearl barley and the cortex of maize. Dry peas and beans are subjected to milling processes substantially as is wheat and other grain, for the manufacture of low grade flours or meals which are used for the manufacture of dog biscuit, cat biscuit *etc.* A by-product of milling the said dry peas and beans is constituted by the aleurone layer of the peas and beans. This by-product, like the bran resulting from the milling of wheat, is a suitable source of supply for use according to the present invention. On account of the high nutrient value of the ingredients mentioned and on account of their particular fitness in other respects they form a basis for the preparation of a high grade food product for human consumption, and also for other technical purposes, such as the development of bakers' yeast, which utilises for its propagation or growth the same material for the building up of the protoplasm as does the human digestive system, and as a basis for vinegar manufacture, distilled spirits, sugars and syrups.

It has been found that when bran or any like material such, for instance, as the offal of pearl barley or the cortex of maize as produced in hominy mills and in corn products manufacture, is mixed with water and maintained at a temperature at which certain bacteria, in the present instance, particularly lactic acid bacteria, can develop, and preferably at temperatures highly favorable for their development, such as 45° to 55° C., the lactic acid bacteria naturally contained in the bran or like will propagate and by their activity form lactic acid, which in turn acts upon the tribasic phosphates which are

[*Price 6d.*]

contained in abundant quantities in such materials, converting the same first into neutral phosphates and these in turn into acid phosphates, while at the same time the lactic acid exerts a proteolytic effect either directly on the proteids of the bran or the like material, or indirectly by liberating proteolytic enzymes contained in the material, which enzymes then exert a digestive effect upon the said proteids. (See Letters Patent of the United States of America Nos. 1,028,508 and 1,006,154).

In this manner the insoluble tribasic phosphates and the insoluble proteids are rendered soluble and assimilable and serve as fit media for the growth of lactic acid bacteria and also for any other organisms, such as yeast, which may be propagated in the said mash after cooling the same to a proper temperature, when the action of the lactic acid has been sufficiently advanced.

A mash prepared in this manner can be used as a basis for the production of beverages, such as beer or distilled liquors, for instance, or for non-alcoholic beverages, by adding to the mash at suitable temperatures gelatinized starch. This added starch is readily inverted by the diastase or amylase contained in the bran. Such amylase is widely distributed in nature, being contained in all cereals and other seeds, also in other parts of most plants; for instance, in the leaves of the hop plant. This amylase is commonly known as trans-location diastase and is assumed by most investigators on this subject to have somewhat different properties from the diastase developed during the germination of seed; for instance, the optimum temperature of inversion of gelatinized starch is given as between 45° and 50° C. for this amylase, whereas for germination diastase (that is, malt diastase) it is commonly considered to be between 50° and 60° C.

According to the present invention the mashing temperature is maintained between 55° and 65° C., so that the full use is made of the translocation diastase.

While this translocation diastase has been the object of considerable study, it has not hitherto been put to any technical use, the quantity contained in various parts of the plants mentioned having been considered too small. It is known that translocation diastase is contained in hops and that this has some influence in inverting the dextrins of ale in the process of dry hopping to sugar, thus causing a more energetic after-fermentation and higher alcoholic content of finished product; also that translocation diastase is contained in certain molds, like the aspergillus-types (aspergillus oryzae) which produce a certain diastase called taka diastase that is technically used in Japan to invert starch to sugar, for instance, in the production of saki. This taka diastase, presumably identical with translocation diastase, has also been introduced in distilleries' processes to invert starch or corn or like material to sugar. This is known as the takamine process or also amylo process. But these diastase containing plants or portions of them do not carry with them the phosphates and proteids necessary to achieve the results obtained from the aleurone layer of seeds. It has been found that the quantity and activity of the amylase contained in bran is sufficient to invert a considerable amount of gelatinized starch between 45° and 70° C., or thereabouts, and that by the aid of this starch, added to the bran mash a wort can be obtained comparable in all respects, as to its suitability for making beer or non-alcoholic beverages, to brewers' wort made from malt with or without the employment of unmalted cereals, the proportion of starch to bran determining the composition of the resultant wort as to carbo-hydrates, dextrin, maltose, proteids (peptones and amino-bodies) phosphates, mainly phosphate of potash. Furthermore it has been found that, due to the difference in action between the amylase and germination diastase, it is possible to control the mashing process to obtain a wort lower in sugar than the ordinary brewer's wort.

Bran as prepared by milling processes ordinarily contains starch mechanically adhering to the bran particles, and this starch being in a raw or crude

state (that is, not gelatinized), is not sufficiently attacked by the amylase of the bran during the mashing process. This mechanically adhering raw starch may be readily removed from the bran, however, by washing. In carrying out this process for the utilization of bran, it is preferred therefore to begin by subjecting the bran to a washing operation, water being used as a washing fluid, and then drain off the wash water, which will carry with it in suspension the starch in solution the diastase and other readily soluble constitutents of the bran, This liquor is allowed to stand until the starch is settled, which will be found to be the case after some hours, say over night. The water may then be drained off, leaving the starch as a sediment, and such starch-freed water may then be mixed with the washed bran to form a mash. The mash is maintained at a temperature of about 45° to 55° C. for about an hour, when a sufficient quantity of lactic acid will be found to have formed and the desired effect on the phosphates and the albumen obtained. The gelatinized starch in the form of boiled starch or as boiled corn, grits, or rice, may then be added to the mash and the mashing operation continued until the desired inversion has occurred, the end temperature of the mash being about 70° C. It has been found convenient to use a substance at present sold commercially under the registered trade mark as "Mazam". Instead of employing starch in the mash, however, for the purpose of obtaining the necessary carbohydrates, dextrine or a sugar in the form of corn syrup, glucose or any suitable sugar found on the market may be used, which contains, as impurity, dextrin bodies. It is also preferred to make use of the starch which settles out of the bran wash-water, having first gelatinized the same by boiling, thus utilizing to the best advantage all of the constituents of the bran,

While the process as described above may be readily carried out, the development of the lactic acid occurring from the propagation of the bacteria naturally contained in the bran, it is preferred to inoculate the mash with lactic acid bacteria or some other acid forming microbe in order to obtain as nearly as possible a development of that kind or species of microbe which is considered most desirable for the particular purpose. The process may be shortened and equally good or better results obtained by adding the lactic acid, as such, to the mash instead of depending upon the propagation of the bacteria and the formation of the lactic acid during the mashing process. For this purpose the "sour liquid" of United States Patent No. 1,028,508 June 4, 1912, is particularly useful and desirable, this liquid containing, in addition to a considerable percentage of lactic acid, acid-forming bacteria of the desired character and activity. It therefore accomplishes the double purpose of inoculating the mash and furnishing lactic acid at the very beginning of the process.

In order to obtain the flavor which kiln-dried malt imparts to beer, caramel malt or roast malt may be added to the mash. Any beer flavoring such as a substance at present sold commercially under the registered trade mark as "porterine", may also be introduced at any stage of the process. Quite satisfactory results, however, are obtained by heating bran in a moistened condition to a sufficiently high temperature to partially torrify it, temperatures between 150° and 200° C. being suitable for this purpose, and then employing a small proportion of this caramelized bran, either dried or in its moist condition, in the mashing process. The preferred manner of producing this torrified bran is to moisten it with from 50% to 200% of its weight of water, and then heat the moistened material very slowly through the lower ranges of temperature, that is up to about 60° C. Lactic acid or "sour liquid" may also be added. During such prolonged heating the bacteria and enzymes of the bran and of said sour liquid will act in precisely the same manner as during the ordinary mashing process, whereby the insoluble and indigestible constituents of the bran become changed to soluble and assimilable constituents. During this process or before, a suitable quantity of

gelatinized starch, or "mazam" may be added and such starch will be inverted in precisely the same manner as during the ordinary mashing process. After the mixture has reached a temperature substantially above 70° the conversion will cease, and the temperature may then be quickly raised to 150° or thereabouts in order to effect the desired torrification or caramelization.

It is found that the amylase developed during the mashing process is capable, under the conditions given, of inverting a very considerable quantity of starch, amounting to two or three times the quantity of bran employed. Worts, mashes, or sugar-containing extracts as high in extract as when mashing with malt may therefore be obtained.

It will be understood from the foregoing that by this invention a method is provided of technically utilising bran and the like materials containing large quantities of phosphates and nitrogenous substances but hitherto considered unsuited for such uses. By this process, moreover, a wort is produced entirely suited to serve as a basis for preparing alcoholic beverages such as beer, or distilled liquors, and also for non-alcoholic beverages and extracts; as a nutrient medium for the propagation of yeast and lactic acid bacteria and other microbes, and as a basis of vinegar production. It will further be understood that by caramelizing bran in a moist condition a characteristic malt flavor may be imparted to the wort. It is, therefore, possible to produce a wort or like product having the same nutrient value and the same flavor as worts produced from malt, by the use of bran and starch only.

While it seems strange that so simple a process for rendering soluble, assimilable and digestible the nutritious constituents of bran and the like should have escaped observation so long, it is believed that this can be readily explained as having resulted from ignorance of the fact that the lactic acid as it is formed (when bran, for instance, is mixed with warm or hot water) becomes at first neturalized by the phosphate of the grain, changing the basic phosphates to neutral phosphates, which takes place without any apparent outward indication. After a time the neutral phosphates are changed to acid phosphates, the presence of which also escapes detection by the casual observer, since these acid phosphates do not react upon litmus, the most common and sensitive indicator for acidity, although phenolphthalein will reveal their presence. It is only after all or the larger amount of the basic phosphates are turned into neutral phosphates and these in turn into acid phosphates, and the continued development of lactic acid results in the formation of free lactic acid in the mash, that litmus will be acted upon; but now the acidification has proceeded so far that the product would be considered unfit for use as a basis for food products. The development of acid if permitted to continue leads to an acidity of one-half to three *per cent.*, the resultant product being the "sour liquid" described in Letters Patent of the United States, No. 1,028,508. Whether the foregoing be a true explanation or not, it is nevertheless a fact that bran and the like cereal products have hitherto been considered unsuitable for use as the basis of a high grade wort, whereas, in fact, it is found that by the present process a wort of the most nutritious, palatable and digestible character may readily be produced from bran and the like cereal products hitherto regarded as wholly unsuitable for this purpose.

As examples of the technical use to which the invention may be put, the following may be mentioned:

ALCOHOLIC BEVERAGES OF THE CHARACTER OF LAGER BEER, WEISS-BEER ALE, STOUT, TAX-FREE BEER, NON-ALCOHOLIC BEVERAGE, ETC.

In the preparation of all of these beverages the materials employed are the same or may be the same as those now in general use, excepting that malt is replaced by wheat bran, rye bran, or any other suitable offal of milling representing the aleurone layer of seeds, such material containing diastase and other enzymes and proteids, which are proteolized in mashing, and an abundance of

phosphates, all of which serve as food for the yeast or other ferment used in the industry. The wheat bran preferably employed should be of selected quality showing upon test a diastatic strength of from 70 to 110° Lintner.

As a material for obtaining the necessary sugar and dextrin a starchy substance such as corn meal, rice, corn flakes or potato starch may be used. The starch should be thoroughly gelatinized as by cooking under proper conditions before use. It is preferred, however, to use the "mazam" before referred to, this product yielding directly and without cooking 95 to 100% of extract.

Where a darker color of beer is desirable, like the color of muenchner, or kulmbacher, the roasted bran before referred to may be used as a substitute for sugar coloring.

Brew-house Operations.

Materials.

For 100 bbls. (barrels) of 31 gals. or 140 hectoliters of finished product use:
Bran, 2,000 to 2,250 lbs. (for a 12—13% wort).
Roasted bran, 100 to 500 lbs. (according to color desired).
"Mazam" or potato starch, 3,000 to 3,250 lbs.
Lactic liquor; about 15 gallons.
Water, about 50 bbls. for mashing in.
Water, about 30 bbls. for mashing up.
Water, about 50 bbls. for sparging.
Hops, about ¾ lb. per bbl.

Mashing.

About 50 bbls. of water of a temperature of 55 to 60 ° C. is run into the mash-tun, which may either be provided with a false bottom serving as a strainer (American and English system) or there is a separate strainer like the Läuterböttich (German system); or the mashing may be done in the cooker; the temperature being so regulated that after the bran is mixed with the water the temperature of the mash is 50° C.; 15 to 20 gallons of lactic liquor of an acidity of 2 to 2.5% and 100 lbs. of "mazam" is then added, the latter being desired to provide sugar for the growth of the bacteria. The mash is now held at 50° C. for one hour, during which time the lactic acid bacteria develop and the resultant acid exerts its desired effect, the trans-location diastase meanwhile acting upon the small quantity of "mazam" present to produce the sugar for nourishing the bacteria. The mash is then rapidly heated to 60° C. and the rest of the mazam is run in, after which the temperature is promptly raised to 70° C. The mash is left at 70° C. for about one hour and then drained into the kettle and there held at 70° C. while the kettle fills, sparging being resorted to as usual. Opportunity is thus afforded for completing the inversion action of the diastase during the filling of the kettle. When the kettle has been filled, the wort will be boiled for about one hour, the first portion of the hops then added, boiled about 30 minutes longer, a second portion of the hops added, boiled about 10 minutes, and the third and last portion of the hops added, when the wort is finished and may be run directly to the hop-jack.

All subsequent operations, as well as the hopping and boiling before referred to, and including straining of the wort from the hops, cooling, yeasting, fermenting, storage and chip-cask treatment, filtration, racking, and pasteurizing in the bottle may be carried out in the manner now practiced in lager beer breweries and in top-fermentation breweries.

Non-Alcoholic Hop Beverages.

In these beverages the wort will ordinarily run about 5 to 6% and the quantities of bran and mazam in the mash will be proportionately less. The materials and manufacturing processes will be the same as those above

described up to the time of finishing the wort in the kettle. An additional amount of lactic acid will be added in the kettle, however, in sufficient quantity to change the neutral phosphates of the wort to acid phosphates, but not enough to obtain a distinct acidity. The desired change will have been effected when blue litmus paper turns to a faint orange color. The amount of acid required is about 10 to 15 gallons per 100 bbls. in the kettle. There should also be an addition of about ¾ ounce per bbl. of table salt in the kettle, and in order to obtain a more characteristic malt flavor, yeast or yeast extract in the proportion of about ¾ lb. of liquid brewer's yeast per bbl. should be added with the first hops. The wort should run about 5 to 6° Balling, and the mashing should be so conducted that the sugar will run about 60 to 65% of the extract, which may be accomplished by raising the temperature as rapidly as possible from 50° (initial) to 70° (end temperature). The amount of hops necessary is about ½ lb. per bbl..

After straining, cooling and chilling the wort to 0° R. it may be allowed to settle over night, after which it is filtered and carbonated. It is preferred also to add sufficient lactic acid at this stage to bring the acid content up to about .03 to .035%, or about one barrel of acid of 2% strength. Further filtration may be required to produce a brilliant beverage.

Chill proofing, *i.e.*, conversion of the colloidal albumen to permanently soluble peptones, may be carried out as is customary in brewing operations by the Wallerstein process. Owing to the absence of alcohol and the presence of some sugar in the beverage, it should be pasteurized at a temperature somewhat higher than that used for alcoholic beverages, 52° R., for instance, the pasteurization bath being heated to 52° R. in 20 minutes, held at this temperature for 30 minutes, and cooled in 30 minutes (for pint bottles). Quart bottles should be held at 52° R. for 40 minutes.

Hop Beverages with Less than ½% of Alcohol (Tax-free).

This beverage is manufactured in same manner as the non-alcoholic beverage above described, excepting that after cooling it receives an addition of yeast, and in the fermenter an addition of lactic acid extracted substances of malt prepared according to Letters Patent of the United States No. 1,117,613 of November 17, 1914, in which is described fully the manufacture of a beverage of this class having from ½% to 1% alcohol, from malt. The characteristic difference in treatment consists in the use of lactic liquor of 1% strength there described as produced by extracting crushed malt of high peptic strength, using one part of malt to four parts of lactic acid, mashing at a temperature of 25° C. for ½ hour, drawing off the liquor, filtering it clear, and chilling it to near the zero point. This liquor is added to the chilled wort a few hours after the addition of the yeast, the quantity added being sufficient to give the finished beverage an acid content of about .035%.

With this product the separate step of chill-proofing is not necessary, as the peptase of malt effects the same results. Since the peptase requires some time for its effects, however, it may be desirable to chill-proof with a more active enzyme, such as pepsin or papaine, where the beverage is to be finished and bottled a day or so after chilling.

Preparation of Distilled Spirits.

Bran can also take the place of malt in the manufacture of distilled spirits. The mash is here prepared in the pressure cooker (Hollefreund or Henze type), unmalted cereals that serve as the starch-bearing or sugar-yielding materials can be used for obtaining the required sugar, treating them in the same manner as is customary, the only difference in the production of the mash being that after cooling the same (after gelatinization is completed under high pressure), the bran is introduced at any suitable temperature heretofore employed when using malt, introducing enough bran to obtain the desired inversion to sugar

and dextrin. The amount of bran to be taken need not be more than $^1/_5$ of the amount of materials treated under pressure in the cooker, and if the starch is thoroughly gelatinized, as small a quantity as 10% may suffice.

Yeast Propagation for Distillers' Mash.

An auxiliary mash is made with the usual materials for yeast propagating, substituting bran for malt, and "mazam" if desired for corn-meal or potato products, and mashing at a temperature of about 50° C., at the same time inoculating with lactic liquor, and allowing the acidity to reach about .2%, when this yeast mash is heated sufficiently high to destroy the lactic acid bacteria, *i.e.*, to about 65° C. This auxiliary yeast mash is then cooled and mixed with the yeast developed as usual for propagation.

Cooling and Yeasting.

The main mash after cooling to the temperature normally employed receives an addition of yeast as usual and of the lactic liquor, which may be anywhere from 1 to 2%, a sufficient quantity being employed to check the growth of noxious ferments, with or without the addition of slop (namely fermented & distilled distiller's mash) to aid the fermentation. The fermentation proceeds as usual, also the process of distilling.

Preparation of Vinegar.

There is no difference in the preparation of vinegar from the ordinary methods employed, excepting that alcohol is derived from a fermented mash in which the bran serves as a source of supply for the diastase and proteolytic enzymes, the process of mashing being practically identical with the one mentioned above for making a distiller's mash; also, the process of yeast propagation and preparation of the auxiliary sour mash with the bran and lactic ferment. The vinegar may be produced from alcohol obtained by distillation (generator process) or directly from the fermented product by the "slow process."

Substitution of Treated Bran for Raw Bran.

In describing the preparation of the various products, such as lager beers, top-fermenting beers, tax-free and non-alcoholic beverages, distilled spirits, vinegar, *etc.*, using raw bran or a like material containing trans-location diastase together with lactic liquor in the mash, such raw bran and lactic acid may be replaced by a manufactured product prepared by mashing bran with lactic acid of about 2% strength at a temperature of about 50° C. for a period of about one hour, and then drying the product at a suitable temperature between 50° C. and 70° C., using similar precautions to preserve the diastase and other enzymes contained in the bran as are customary in the production of malt in the kiln-drying process.

The amount of lactic acid used for mashing the bran as above described should constitute about one-half of the weight of bran, the moist bran thus acidulated being kept a few hours at a temperature of 50° C. until about air dry, when it is heated to 70° C. until it is dried about like malt with a percentage of moisture of 3 to 4.

Method.

When using this dry acidulated bran in the preparation of lager beers, top fermenting beers, distilled spirits, *etc.*, the lactic acid need not be especially prepared for use in the mash in order to effect proper extraction of the bran, and the same mashing temperatures may be employed as if malt were used. In the preperation of distilled spirits, beers and vinegar, however, the same benefits accrue in preparing lactic acid from bran in place of lactic acid from malt, or other materials, as described in the foregoing.

In the preparation of non-alcoholic beverages or beverages with less than one-half *per cent.* of alcohol it is necessary to add lactic acid or the lactic acid extracted substances of malt, as described in the foregoing, in the kettle and after cooling.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. The process of mashing starchy materials as carried out in the technical production of worts, fermented and distilled beverages, yeast propagating mashes, sugar carrying extracts and kindred arts, characterised by the use of wheat bran or a similar ungerminated vegetable product containing translocation diastase to produce the conversion of the starch in the mashing process.

2. The process according to preceding Claiming-clause 1 characterised by the use of lactic acid or lactic acid bacteria or both in the mash.

3. The process according to preceding Claiming-clause 1 consisting in using a dried wheat bran which has been treated with lactic acid instead of or in addition to the natural bran.

4. The beer-like product produced by the herein described process characterised by the fact that it is free of malt derivatives.

5. The process of mashing starchy materials substantially as described.

Dated this 7th day of April, 1916.

BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London, E.C.,
Chartered Patent Agents.

Reference has been directed, in pursuance of Section 7, Sub-section 4, of the Patents and Designs Act, 1907, to Specification No. 2587 of 1896.

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